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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

FOREST INSECT INVESTIGATIONS

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TITLE

MOUNTAIN PINE BEETLE CONTROL PROJECT
CRATER LAKE NATIONAL PARK, OREGON
Season of 1947

by

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January 31, 1948

SUBJECT—

INDEX NO.—

U. S. GOVERNMENT PRINTING OFFICE 16—47272-1

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MOUNTAIN PINE BEETLE CONTROL PROJECT

CRATER LAKE NATIONAL PARK, OREGON

Season of 1947

Approved by:

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341 Giannini Hall, U.C.
Berkeley, California
January 31, 1948

MOUNTAIN PINE BEETLE CONTROL PROJECT
CRATER LAKE NATIONAL PARK OREGON

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FOREWORD

The mountain pine beetle control project carried out in the spring of 1947 in Crater Lake National Park, Oregon, resulted from a survey made in the fall of 1946 by National Park Service officers and M. L. Furniss of the Portland, Oregon laboratory of the Bureau of Entomology and Plant Quarantine.

In reporting the infestation conditions found Furniss stressed the fact that the mountain pine beetle had recently increased its activity within the park and had developed infestation centers where group attacks had resulted in greatly increased timber losses. He also found that the general infestation showed aggressive tendencies and might soon become widespread.

The decision to arrest this infestation before losses could become epidemic, or the damage spread to other areas, was made by the National Park Service on the basis of this report. Therefore, a fund of $5,000 was made available for immediate use, and at the same time the Bureau was requested to cooperate to the extent of administering the technical phases of the proposed control work. John M. Patterson, of the Berkeley, California, laboratory was detailed to act as entomological consultant.

Since late fall control work against this insect in lodgepole pine forests is not ordinarily advisable due to adverse weather, and late seasonal beetle attacks, it was decided to postpone the work until the spring period of 1947. In the meantime the control fund was alloted to the Superintendent of Crater Lake Park and preparations for carrying out the project were completed in early May. Patterson established headquarters in the park and Park Superintendent E. P. Leavitt assembled the personnel and working equipment. Roads to the control areas were cleared of snow and the project got under way on May 14.

HISTORICAL NOTE

The known history of mountain pine beetle infestations in the lodgepole pine stands of this park goes back to 1919 when an active epidemic of this barkbeetle was reported to the Ashland, Oregon, laboratory of the Bureau. An examination was made by Patterson in 1920 when it was found that the entire northern section of the park was infested and many areas had been completely devastated. However, the beetles had not yet appeared in other sections of the park and as the infested areas were remote and seldom visited nothing was done about the situation. By 1923 these northern stands had been completely attacked and the infestation was spreading to the large lodgepole stands in the southeastern section of the park. The situation had become serious as all the southern recreational stands were threatened with destruction similiar to that which had occurred in the northern stands.

In an attempt to save the forests south of Crater Lake the National Park Service set up funds for control work to be carried out in 1925. The Bureau cooperated in this first project by detailing Patterson to administer the technical phases. The control work in 1925 was confined to that part of the southern forests where active infestations were present. About 4,291 infested trees were treated. Unforutnately infiltration of beetles from the northern epidemic areas continued so it was necessary to resume the control through 1926 and 1927. Because control funds were not available in 1928 no work against the beetle was carried out in that year. In the mean time hordes of beetles had invaded new areas south and west of the lake and conditions had become critical in these forests. The previous control work had not been enough to fully protect the recreational forests of the southern park, principally because of continued migration of beetles from the northern forests where no control work had been done. In 1929 the Park Service made an all out effort to eradicate the beetle in the southern and western areas by treating 23,544 trees. Operations during this year succeeded in breaking up the epidemic and as the infestations in the northern section had run their course and had subsided no further migration of beetles from this source occurred. Simultaneously in 1929 the United States Forest Service carried out control operations by treating 3,116 infested trees in lodgepole stands adjoining the park at Sand Creek and Cavern Creek.

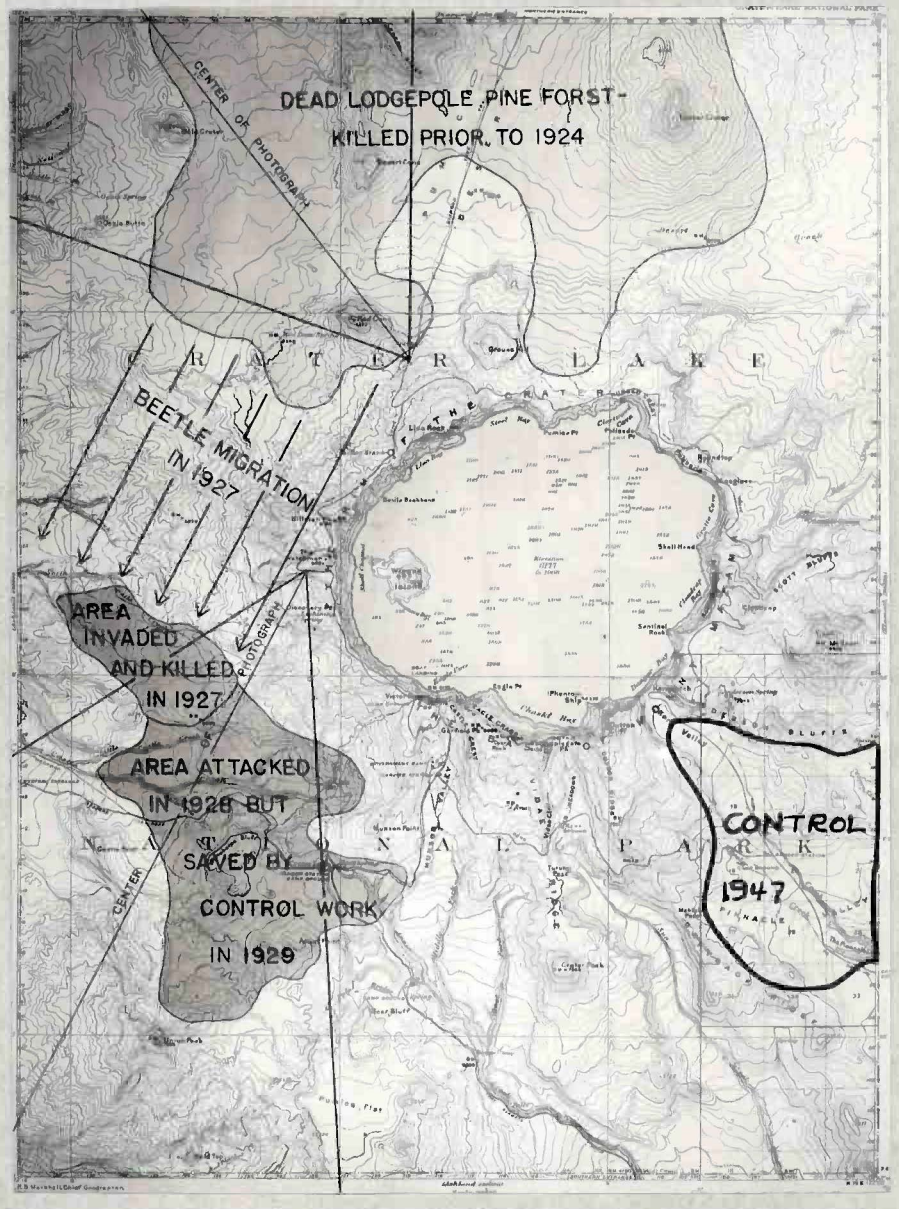
While the control operations in 1929 were successful in breaking up the epidemic, the infestation was not entirely eliminated on the recreational areas. Control work directed against this residual infestation was therefore continued annually during the three succeeding years so that by 1933 it had been reduced to the point where infested trees could no longer be found on the control areas. During this last three-year period, F. P. Keen of the Portland, Oregon laboratory of the Bureau was in charge of the entomological phases of the work.

During the entire control period from 1925 to 1932, a total of 170,000 infested lodgepole pine trees was felled and treated. The cost of the entire operation totalled $120,000.

The control established endured for over a decade. During the years intervening between control of this first epidemic in 1933 and the development of the present infestation in 1946 the mountain pine beetle was inactive in the park forests. Annual surveys made during this period failed to reveal any active infestation. The first noticeable change in this status occurred in 1945 and by 1946 epidemic trends were again pronounced, signifying another epidemic cycle.

Several different methods of treating infested trees were tried out during the first year of this extended project. Burning in place was early rejected because of scorching of nearby green trees. Burning in piles was far too expensive, as well as impractical due to great depth of snow. Peeling of logs was also expensive and impractical. Late in 1925 it was discovered that sun curing infested logs was effective and practical and could be done at a cost per tree far below any other method known at that time. This method, which became known as the "solar-heat" method was the most important method during the succeeding years. The technique involved in the application of this method consists of: 1. falling the trees in open situations with the bole lying in a north-south direction; 2. removing all limbs and the tops; 3. exposing the entire infested length of the trunks to the direct rays of the sun for a period of two or more days; 4. rolling the logs after first exposure full 180 degrees thereby exposing the opposite side of the logs to direct sunlight. In this way the entire surface of the logs are exposed to lethal temperatures. In this latitude, and within the elevation ranges of the control areas, bark temperatures as high as 140 degrees F. were attained. Since bark temperatures ranging between 110 and 120 degrees are fatal to broods of the mountain pine beetle such treatment is highly effective in killing broods of this beetle. As an historical item this was the first barkbeetle control project which employed the solar-heat method of control on large scale.

In 1930 an oil burning method was developed by W. J. Buckhorn and Frank Solinsky which proved to be especially effective for treating trees in dense shade where the sun-curing method was inoperative. Trees were felled, a fire started at one end of the log and then carried along the log by spraying on fuel oil to the point where bark flakes curled and turned to ash along the edges. The cost of this method was only slightly higher than the solar heat method and fully as effective in killing broods.



Map of Crater Lake National Park showing evolution of mountain pine beetle infestations during the period 1924 to 1929. Beetles migrating from the first established center in the northern part of the park invaded the southern areas causing great losses in these recreational stands. Control work during the period 1925 to 1932 was directed against infestations in all the southern forests. Areas where control was carried out in 1947 are shown encircled south-east of Center Lake.

THE 1947 CONTROL PROJECT

Physical Setup: The personnel employed on this project consisted of a project foreman, spotting crew leader, three spotters and five treating crews of two men each. A carry-all personnel truck, and pickup truck, were provided for transportation of men and equipment to the control areas. The personnel was quartered at Park Headquarters and transported daily to and from work. The control period began on May 14 and the project was completed on June 25.

Plan of the Field Work: Location of the field work was determined by the Bureau representative. The infested trees were then spotted from base lines established through the infested areas and tied to section corners when available, otherwise these lines were arbitrarily tied to prominent topographical features. Survey strips were 5 chains wide so that each spotter had a very narrow strip to traverse thereby assuring complete coverage. Center lines were run by compass and pacing.

The treating crews were under the direct supervision of the project foreman who directed the progress of the work and allocated the crews for maximum accomplishment and continued production. All infested trees were felled, limbed, and topped. The solar-heat method was used whenever possible in treating lodgepole pine. When shading could not be avoided oil sprays fortified with 5% DDT, or 20% orthodichlorobenzene, were used in the infested length of the stems. The lower stems of all infested white pines were peeled and the tops either peeled or sprayed with fortified oil sprays. All stumps were peeled.

Insects Responsible: The mountain pine beetle, Dendroctonus monticolae, Hopk., was the only primary insect involved in this infestation. Small broods of Ips Oregoni Eichh., were occasionally found in tops of infested trees but they were of no importance in this infestation. In this latitude, and within the elevation ranges of the control areas, the mountain pine beetle develops one complete generation each year. Hence, during control periods (normally May 1 to July 10) the entire beetle population is lodged in trees attacked the preceding summer and fall seasons although broods are in various stages of development, including larvae, pupae and new adults. Some overwintered parent adult beetles are also present in green sections of trees. These may deposit eggs during the control period. However, no beetles are in flight during the period so that it is possible to attack the entire population which is restricted to the infested trees.

Broods in Lodgepole Pine: These were generally normal in quantity and dispersion along the tree stems. A number of trees were found with only partial brood, the other part having emerged the previous season. The number of such broods was not great and they usually occurred where groups of trees were attacked. Strip attacks were not common in this infestation. All infested trees were treated regardless of the size of the Brood.

Brood in White Pine: All infested white pines contained very large broods. These trees were usually infested from root collar to the extreme tips. In general these broods were farther advanced than mountain pine beetle broods in lodgepole pine. Pupae began to form in early June and callow adults had developed by late June. At the end of the control period on June 25, broods in lodgepole were still largely in the larval stage.

Cost of the Project: The total cost of the project was $3,767.46. A break down of this total cost apportions it to the following items:

Wages	$3,212.96
Materials and supplies (Sprays etc)	107.40
Equipment rental (trucks and tools)	170.80
Warehouse issues	3.15
Patterson's expenses (travel & subsistence)	273.15
Total	$3,767.46

The cost per tree treated was $3,685. This figure is in excess of previous costs of treating similiar infestations in this park, and is accounted for by increased labor costs, more scattered infestation, and a smaller project entailing greater proportionate overhead. A sixteen-day period of continued rain and snow in late May and early June affected costs in lowering daily production. Also some of the logs felled during this period were re-rolled at additional cost. It was later determined that this extra labor was not necessary but was thought best at the time and was done as a safety measure to insure complete kill of these broods and prevent any live beetles from escaping.

Infested Area Worked: The areas covered by control operations totaled 9,440 acres situated in the southeastern section of the park. A discussion of the size and characteristics of these separate control areas follows:

Area 1 - Lost Creek: Approximately 960 acres of flat plateau lying between Sand Creek and Wheeler Creek. The timber type is lodgpole pine in pure stands. Previous infestations were stopped by control work before heavy losses had occurred, hence the present stand has a high content of mature trees. The 1946 attacks were highly groped and the infestation was largely confined in the larger, more mature trees. A total of 379 infested trees were felled and treated by the solar-heat method. Since these stands still contain a large percentage of mature trees they are highly susceptible to mountain pine beetle attack. Close observation on subsequent events is desirable during succeeding years. The area is readily accessible for observation and examination from roads which traverse it.

Area 2 - Wheeler Creek: This area occupies the rolling terrain west and south of Wheeler Creek and extends back to the fir type on Grayback Ridge and Maklaks Peak. Its area is 2,640 acres, and the lodgepole pine stands are greatly broken by openings and by tongues of fir extending down from the higher elevations. The southern part of the area suffered severely in the epidemic of 1925 and 1946. Great devastation by mountain pine beetle occurred in the years before the control work carried out in 1925 and 1926 brought the infestation under control. As a result of these severe losses the residual stands are largely depleted of susceptible mature trees. The 1946 attacks occurred in the main on individual trees scattered over the whole area. A total of 109 infested trees were treated by solar heat. Since the remaining stands are greatly composed of young trees and reproduction it is not probable that a large infestation can develop in the forseeable future.

Area 3 - Kerr Valley: This area lies in the narrow valley between Sand Creek and the abrupt east face of Dutton Ridge, and from the Lost Creek Campground to Kerr Notch. It comprises 1,260 acres of flat topography. The pine type consists of a mixture of lodgepole and white pine. There is a high content of red fir and hemlock. Past insect losses have been light so that the present stands contain a high percentage of mature trees susceptible to attack. The 1946 attacks were largely grouped in lodgepole pine, but were scattered in white pine. A total of 127 infested trees were treated on the area. This total included several white pines of large size infested with very heavy broods of beetles. The infested lodgepole pines in open situations were treated by solar heat. Those in shaded positions by DDT, or orthodichlorobenzene, in fuel oil. The infested white pines were peeled and the upper boles sprayed with these fortified oils

Area 4 - Sand Creek: All the pine stands between the eastern boundary of the park and Sand Creek Canyon, and from the Pinnacles north to Anderson Bluffs are included in this area. In size it comprises about 3,800 acres. The timber type is pure lodgepole pine on the sand flats in the southern half of the area. North there is considerable white pine, with fir and hemlock on the higher points. The western part of the area was greatly devastated by the mountain pine beetle in the years prior to 1932. The depleted stands on this section are largely composed of pole-sized trees, with scattered mature specimens. Northward, the mixed stands contain a high percentage of white pine and mature lodgepole pine. The 1946 attacks of the mountain pine beetle were greatly scattered in the depleted stands but were largely grouped in mature stands. It was in these mature stands of mixed lodgepole and white pine that the 1946 infestation was of highly aggressive character. Attacks had been heavy and resultant broods of beetles were of maximum size. Greatly increased infestations were imminent in these stands so the control work was timely in preventing epidemic losses. A total of 386 infested trees were treated in the area, principally in the northern part. Infested lodgepole pines were treated by solar heat. All the

infested white pines were peeled.

This area should be closely watched in the future; both because of the susceptible stands in the northern part, and also because there is a scattered infestation in lodgepole pine outside the park parelleling the eastern boundary. This adjoining infestation is on Forest Service lands but is continuous with park infestations. Since this outside infestation was not within the limits of the control project several scattered infested lodgepole pines spotted along the eastern boundary opposite the ForestService infested lands, in all 21 trees, were not treated.

Area 5 - Munsen Valley: The valley immediately south of headquarters comprises this area of 580 acres. The stands of lodgepole pine are of high park value and should be protected from even slight losses. The 1946 attacks by the mountain pine beetle were light, consisting of only two small groups totaling 17 infested trees. These were felled and treated by solar heat, or with fortified oil sprays. The current infestation had only recently appeared on this area and its early removal should afford protection. However, the area should be closely watched for recurring attacks.

Area 6 - Anne Creek: The mixed pine stands along the west side of Anne Creek canyon are included in this small area of about 200 acres. It was relatively free of infestation and required small attention. However, some small groups on infested trees were removed to clean up the stands. These trees were treated with fortified oil sprays.

TABLE - Infested areas covered by control work and number of trees treated in each.

Area	Size in acres	Number of Trees spotted	Number of Trees treated
1 - Lost Creek	960	379	379
2 - Wheeler Creek	2,640	109	109
3 - Kerr Valley	1,260	127	127
4 - Sand Creek	3,800	407	386
5 - Munsen Valley	580	17	17
6 - Anne Creek	200	4	4
Totals	9,440	1,043	1,022

Total cost of project $3,767.46
Cost per tree treated 3.685

The treated trees ranged in size from 6" DBH to 48" DBH.

DISCUSSION

The character of the 1946-47 infestation supports the assumption that increased losses would have resulted had it been left to run its normal course. The salient points of this infestation were: (1) greatly increased number of trees attacked over immediate preceeding years; (2) closely knit grouping of attacks without selection of mature trees only (in the great majority of group attacks trees of all age classes were attacked); and (3) spreading of the infestation from established centers.

In an appraisal of the development of the current infestation the presence of dead trees, killed during the 8-year period preceeding the 1946 attacks, was of prime importance. Considerable time was spent in dating the attacks on these dead trees. It was possible to date the loss with accuracy for the last four years of this period. Dating older loss was largely guesswork, but it was fair to assume that some of the snags had been killed at least 8 years previously. The trend during the period was fairly obvious and showed both increases and retrogression of infestations over the whole period. Of significant value was the consistent increase in number of trees killed during the last 3 years of the period. This trend left little doubt but that the infestation had started on a sustained upward swing, possibly the beginning of an infestation cycle. These incipient infestations also shed some light on how infestations continue through the low stages of a cycle, maintaining themselves in overmature trees in low endemic status, however, persisting and remaining a constant potential source of epidemic infestations.

The reduction of the 1946-47 infestation accomplished by the control work carried out should establish adequate control for the present and prevent the heavy losses which otherwise would have occurred. It will not, however, prevent subsequent infestations developing on the same areas in the future, or obviate the necessity of annual observation on the areas worked. These will be necessary to detect any change in the present low status.

The presence of incipient infestations in adjoining stands outside the park is a constant menace endangering the park stands along the east boundary, and it may be necessary to remove this outside infestation before full protection is afforded the park forests. Periodic inspections will reveal any threatening increase in these bordering infestations.

The high recreational values of the pine forests of this park warrant complete protection from insect losses and justify a program of constant detection and annual removal of attacked trees. Such a program can be carried out by inaugurating maintenance control whereby incipient infestations are removed annually thereby preventing the occurrence of abnormal losses.

SUMMARY

A survey of forest insect conditions in the southern lodgepole pine forests of Crater Lake Park, Oregon, was made in the fall of 1946. This survey revealed that infestations of the mountain pine beetle, Dendroctonus monticolae Hopk., had recently increased in intensity and were spreading from older centers to new areas throughout these stands. To prevent further spread and increased insect losses in the principal recreational stands the National Park Service allotted a sum of $5,000 for control of the infestation.

The Bureau of Entomology and Plant Quarantine had conducted the survey in cooperation with Park personnel and was requested to cooperate in carrying out the control work, which was planned for the spring period of 1947.

The control funds were made available to the Park Superintendent and actual control operations were started on May 14. The project was completed June 25. A Bureau representative was resident on the job throughout its duration. He set up the control areas, demonstrated the methods to be employed, and inspected the completed work. Six different areas, totaling 9,400 acres, were covered by the control work. These areas were located in the southeastern and central sections of the park. A total of 1,022 infested trees were felled and treated. These were principally lodgepole pine. A number of mountain white pine trees is included in this total.

Mountain pine beetle broods were normal in lodgepole pine and were extra heavy in white pine.

The solar-heat method of control was generally used in treating infested lodgepole pine. Fortified oil sprays, containing 5% DDT, or 20% orthodichlorobenzene, were employed in shaded situations where solar heat is ineffective. The white pines were peeled and treated with fortified oil sprays.

The total cost of the control work was $3,767.46. The cost per tree treated was $3.685.

The control work was timely in preventing high losses in the recreational stands since the infestation had become aggressive and had established new group attack centers throughout these stands.

Periodic examinations of all susceptible stands of lodgepole pine within the park and in adjoining forests of the same type should result in detecting increasing infestations before they become damaging. This course is urgently recommended.

Maintenance control annually carried out within the recreational stands most susceptible to barkbeetle attack offers the greatest protection against losses from these insects. It is hoped that such measures be adopted for this park.

SUPPLEMENT
SURVEY OF FOREST INSECT CONDITIONS, CRATER LAKE NATIONAL PARK - GALL SEASON OF 1947

An insect survey of Crater Lake National Park, and of the adjoining timbered areas, was made in early October 1947. The purpose of this survey was two-fold; (1) to determine the immediate results of the barkbeetle control work carried out during the preceeding spring period, and; (2) to ascertain the amount and character of infestations on adjoining areas which might endanger control already established on the park areas worked.

The personnel of the survey part consisted of Fred Patton, Insect Control Foreman, Crater Lake Park; and John E. Patterson of the Forest Insect Laboratory, Berkeley, California. The survey was carried out during the period September 20 to October 8.

AREAS COVERED:

The following forested areas were covered by this survey:
1. Control Areas: These included all the areas whereon control work was carried out during the preceeding spring period. They totaled 9,400 acres.
2. Cavern Creek: This area is situated in Rogue River National Forest and adjoins the Sand Creek control area within the park. The stands of lodgepole pine are continuous with park forests.
3. Bear Creek: Northeastern section of park. Contains mixed stands of lodgepole pine, ponderosa pine, and white fir.
4. Red Cone: Lodgepole pine stands of northwestern section of park.
5. Castle Creek: Lodgepole pine stands in Castle-Coppeland creeks drainage. West central section of park.
6. Union Peak; Pine stands of south-western section of park.
7. Anne Creek-Sun Creek: The drainage basins of these two creeks in south-central section of park.

CURRENT INFESTATION CONDITIONS ON CONTROL AREAS

Conditions developed during the 1947 season show the immediate results of the control work carried out during the preceeding spring period.

Lost Creek: This was the most heavily infested area covered by the control work. This pre-control loss amounted to 379 infested trees. It was cruised by running 5 chain strips on random lines through the central part of the area. These strips totaled 160 acres. Altogether 9 infested trees were marked. On this basis, the total recurrent infestation would amount to 22 infested trees on the entire control area - a reduction of 94% over pre-control infestation.

Wheeler Creek: Pre-control infestation on the area amounted to 109 infested trees. Post-control infestation was determined by running traverse strips aggregating 80 acres. Only 3 infested trees were located indicating a total infestation of about 12 trees; a reduction in prior losses of 89%.

Kerr Valley: A total of 127 infested trees were treated in control. Traverse strips totaling 80 acres were surveyed in the lodgepole pine stands without picking up any infested trees. However it is estimated the 1947 attacks will total around 12 trees, a reduction from former status of about 90%.

Sand Creek: The pre-control infestation on this large area was greatly scattered, with heavy concentration on only a relatively small acreage. Strip cruises totaling 200 acres resulted in marking only 2 infested trees. It is estimated the total post-control infestation will amount to about 50 attacked trees. This amount marks a reduction in losses of 87%.

Munsen Valley: The pre-control infestation on the area was lodged in two small groups totalling 17 infested trees. The survey strips covered 40 acres with no loss recorded. No post control infestation is expected to develop in 1947.

CURRENT INFESTATION CONDITIONS ON OUTLYING AREAS

Cavern Creek: This area was surveyed by strip counts and general reconnaissance. The 1946 infestation was endemic and sparsely scattered along the eastern park boundary. It was of light intensity and without group formations. It is expected that the 1947 infestation will register some increase over 1946. Presently it is not greatly endangering the adjacent park control areas but a pronounced increase would become a menace to these controlled areas.

Bear Creek: This area lies north of Scott Peak and has no connection with the control areas. An incipient infestation in lodgepole pine has persisted here for several years but shows no present signs of aggressiveness. It is not currently causing notable damage. The 1947 survey was accomplished by making road traverse estimates.

Red Cone: This remote area is quite distinctly separated from any other park areas and is currently free of infestation. It is considered a safe risk without attention other than infrequent examinations.

Castle Creek: The lodgepole pine stands in this west-central area are highly susceptible to barkbeetle attack and suffered severe losses in the epidemic of 1928 to 1931. Since that time and prior to 1946, infestations were quietescent with almost no losses. In 1946 a few small groups of attacked lodgepole pine appeared, principally between Castle and Copeland creeks. The 1947 fall survey showed that these groups had

increased in size and the infestation had spread throughout the stands. It showed every indication of becoming aggressive. The total loss for 1947 is estimated to reach 80 to 100 trees.

Union Peak: The survey revealed that infestation in these stands is currently non-existent. No attention other than infrequent examinations need be given it.

Anne Creek-Sun Creek: These areas were covered by general reconnaissance, with some ground sampling in certain parts where incipient infestations were suspected. In general the stands are quite free of infestation in lodgepole pine. A few infested trees in a small group west of Anne Creek were treated in the spring control work. These areas are expected to remain free of damaging infestations during the immediate future. Conditions in the ponderosa pine stands, of the "pan-handle" are, however, quite different, particularly in the road screen paralleling the south entrance road. Here infestations of the western pine beetle, Dendroctonus brevicomis Lec., have persisted in a semi-epidemic state for the past several years. A ground survey of the area showed that the annual attrition due to this beetle has been between 15 and 20 large sized ponderosa pine trees. This rate of loss was in no way diminished during the 1947 season. A continued loss at this rate would early and greatly deplete these stands of the larger, mature, trees and thus defeat the purpose of the road screen which is to maintain a fully stocked virgin forest on this approach to the park. These losses are the more deplorable because many of the killed trees are situated at the roadside and highly visible to visitors traveling this road. The total loss in these stands during 1947 was estimated to amount to 30 trees, principally of large size.

RECOMMENDATIONS

The control work carried out last spring against the mountain pine beetle in lodgepole pine stands was successful in greatly reducing the prevailing losses on all the areas worked. In no case has the post-control loss amounted to more than 15% of the 1946 loss. Infestation on these areas was not, however, entirely eliminated and since there is a residual infestation left on most of the control areas future management should recognize this conditions. It is felt that a limited amount of control work should be done in 1948 in order to maintain the low status established by the control operations of last spring. Such work would be of the nature of maintenance control practiced in some other National Parks demonstrating the practical benefits accrued from this course. To successfully accomplish maintenance control in 1948 will require the following estimated amount of direct control work;

Lost Creek:	800 acres	25 to 30 infested trees
Wheeler Creek:	500 acres	15 to 20 infested trees
Kerr Valley:	600 acres	15 to 20 infested trees
Sand Creek:	900 acres	50 to 60 infested trees
Totals	2,800 acres	105 130

The increasing infestation in lodgepole pine stands in Castle and Copeland Creeks drainage basins should be given attention. No control work was done in this section last spring because the infestation was not known to exist until after the control period had passed. These infestations are aggressive and show every indication of increasing within the 1948 season. The amount of current infestation necessary to treat in the spring of 1948 is estimated to amount to 80 to 100 trees.

In order to protect the south entrance road screen in the "panhandle" from further damaging losses by the western pine beetle it will be necessary to remove the present beetle infestation. It will be desirable to eliminate as much of this infestation as is practically possible the first season of work. This area is readily accessible and conditions are favorable for control by direct methods at minimum costs. The current loss is estimated to be between 20 and 25 trees, principally of large size.

Cost of Control work Proposed:

The per unit cost of treating lodgepole pine in last spring's control operations was $3.68. However, much of this infestation was grouped and therefore unit costs were minimum. In maintenance control work the infested trees are generally scattered and costs per tree usually run higher. Similiar attributes apply to the infestation in Castle-Copeland area. Therefore control costs for mountain pine beetle infestations in lodgepole pine considered for the 1948 season should average about $4.00 per treated tree,, totalling about $700 to $900 for treating the 185 to 230 trees estimated. Control costs of treating ponderosa pine trees infested with the western pine beetle will be much greater, perhaps $15 per tree. On this basis the cost of the work considered for the "panhandle" would amount to about $375.

Control Methods Recommended:

Mountain pine beetle broods in lodgepole pine in this park are best treated by the solar-heat method where trees can be fully exposed to sunlight. In shaded situations they should be sprayed with 5% DDT in fuel oil.

In treating ponderosa pine infested with the western pine beetle it is necessary to peel the infested bark from off the logs and where fire hazard is not great, to burn the bark. If burning is not safe the peeled bark may be sprayed with the same spray recommended for lodgepole pine.

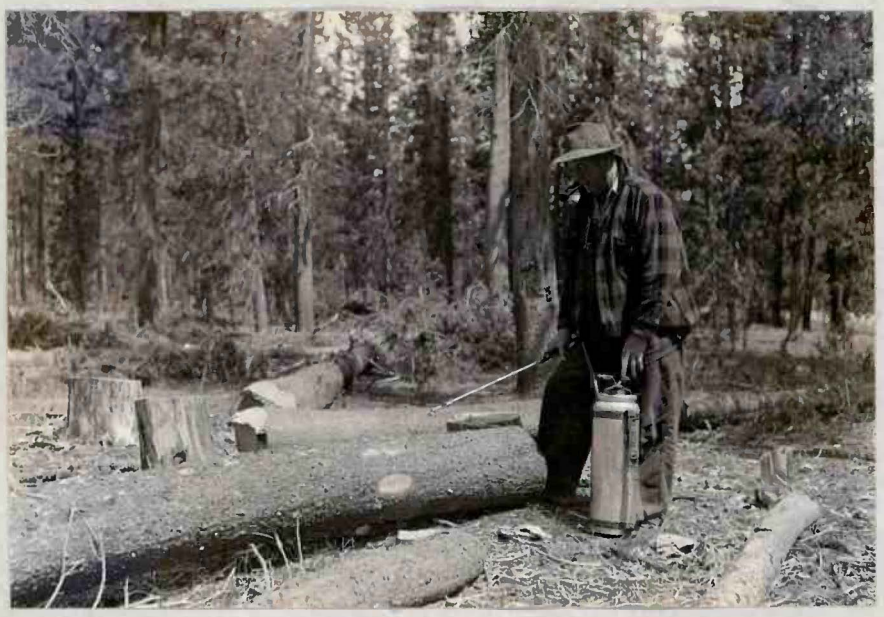
Timing of Control Work:

Since western pine beetle broods emerge from overwintered brood trees in the "panhandle" early in May it will be necessary to complete this part of the season's control work before May 5. Treatment of mountain pine beetle broods in lodgepole pine may be done any time prior to June 20. In this park it is usually possible to begin the work in early May in the lower altitudes and finish some time later in May of June in the higher altitudes.

A mature lodgepole pine tree felled in position for solar-heat treatment to kill the infesting brood of the mountain pine beetle, Dendroctonus monticolae Hopk.

A small group of infested lodgepole pine trees felled and exposed for treatment by the solar-heat method. It is best for maximum exposure to fell the trees in a north-south direction.

A large group of lodgepole pine trees infested with broods of the mountain pine beetle which have been felled and exposed for solar-heat treatment. Note the trees are laid down in one direction only - on north-south axis.



Trees in shaded positions cannot be successfully treated by the solar-heat method since direct sunlight cannot reach them. In all such cases the trees were sprayed with fortified oil sprays which were applied with a standard model back-pack pressure sprayers as illustrated.

Stumps were peeled since the solar-heat and oil spray treatments are not fully effective in killng broods in stumps. Generally stumps were completely infested to the root collar. Hence it was necessary to treat them.